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SAULT COLLEGE OF APPLIED ARTS & TECHNOLOGY

SAULT STE. MARIE, ONTARIO

COURSE OUTLINE

Course Title:	MECHANICS OF FLUIDS
Code No.:	MCH 301
Program:	MECHANICAL TECHNOLOGY
Semester:	FIVE
Date:	JUNE, 1983
Author:	W. JENKINS

New: ______ Revision: X

APPROVED: L.P. Crozietto
Chairperson Date

MECHANICS OF FLUIDS
Course Name

MCH 301
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PHILOSOPHY/GOALS:

Successful completion of this course will mean that the student will have a sound knowledge of the various means of hydro-electric power generation; and an ability to correctly select pumps for fluid flow applications.

METHOD OF ASSESSEMENT (GRADING METHOD):

You will be tested on topics 1, 2, 3 two weeks after completion of these topics.

You will be tested on topic 4 two weeks after completion of this topic.

You will be tested on topic 5 at the end of the course.

The marking system will be A, B, C and X, and tests will be graded on logical solution, layout, sketches and neatness.

It is expected that the student will be a punctual, diligent and regular attender in class.

TEXT:

Fluid Mechanics - Daugherty & Franzini

Vickers - Industrial Hydraulics Manual

REFERENCES:

Fluid Mechanics - Binder - (Prentice-Hall)

Fluid Mechanics- Streeter

MECHANICS OF FLUIDS

MCH 301

UNIT #1 - Dimensional Analysis

General Objective: The student will be able to utilize dimensional analysis to deduce formulae dealing with fluid flow.

Specific Objectives:

1. To be able to recall the method of applying units when dealing with mathematical formulae.
2. To be able to define the term dimensional homogeneity.
3. To be able to equate indices on both sides of an equation.
4. To be able to develop the formula where resistance to flow depends on density, velocity and a linear dimension.
5. To be able to produce the Weisbach formula from specific objective 4.
6. To be able to produce the Chezy formula from specific objective 4.

UNIT #2 - Dynamical Similarity

General Objective: Using Dimensionally or Geometrically similar systems, the student will be able to apply Dynamical Similarity in the analysis of fluid systems.

Specific Objectives:

1. To be able to define inertia.
2. To be able to define viscosity.
3. To be able to define centrifugal force.
4. To be able to develop a formula for centrifugal force which is dependent on velocity viscosity and scale.
5. To be able to develop a formula for viscous force which is dependent on velocity viscosity and scale.
6. To be able to develop from specific objectives 4 and 5, the formula for Reynolds Number.
7. To be able to develop, from specific objective 6 the formula for Froudes Number.
8. Using the above specific objectives, the student will solve correctly the following problems: -7-7, 8, 9, 10, 11, 12, 13, 14, 15 and 16.

UNIT # 3 - Pelton Wheels

General Objective: The student will be able to solve a number of problems dealing with Pelton Wheel design.

Specific Objectives:

1. To be able to recall the formula for force due to change in momentum.
2. To be able to define the term torque due to change of moment of momentum.
3. To be able to recall relative velocity.
4. To be able to produce the inlet and outlet velocity triangles for a Pelton Wheel.
5. To be able to obtain the condition for maximum power developed in a Pelton Wheel.
6. To be able to calculate the efficiency of a Pelton Wheel.
7. To be able to derive a graph of efficiency against the ratio of wheel speed to jet speed.
8. To be able to recall the formula for nozzle efficiency.
9. To be able to solve problems of the following type:

   A pelton wheel driven by two equal jets is to develop 1200 h.p. at 500 r.p.m. when supplied with water under a head of 500 feet. Calculate suitable diameters for the wheel and the jet. Assume an overall efficiency of 0.8, Co for nozzle = 0.98, bucket to jet speed ration = 0.46, bucket outlet angle = 20°, bucket velocity coefficient k = 0.88. Estimate the hydraulic efficiency of the wheel.

UNIT #4 - Impulse and Reaction Water Trubines

General Objective: The student will be able to successfully deal with numerous aspects of water turbine design.

Specific Objectives:

1. To be able to distinguish between impulse and reaction turbines.
2. To be able to recall kinetic energy.
3. to be able to recall pressure.
4. To be able to recall total head.
5. To be able to recall the formula for torque due to change of moment of momentum.
6. to be able to recall the formula for angular work done/sec.

7 To be able to state the runner equation for a turbine.

8. To be able to produce the inlet and outlet velocity diagram for a turbine.

9. To be able to state the formula for the hydraulic efficiency of a turbine.

10. With the aid of the above specific objectives to be able to deal with problems similar to:

    Example: A parallel flow impulse turbine develops 120 hp at 200 rpm under a supply head of 100 ft. If the friction loss in the pipe is 10% of supply head and C = 0.95 estimate the blade angles at inlet and outlet and the mean dia. The guide vane angle is 20° and the water leaves the runner axially. The velocity of discharge 1/2 the axial velocity at inlet. If the depth of the runner in the radial direction is 6" and the runner passages run 90% full, calculate the arc subtended by the guide vanes.

11. With the aid of the above specific objectives to be able to deal with problems similar to:

    Example: In an inward flow reaction turbine the wheel dias. are 4' 0" and 2' 6" respectively and the M/C operates @ 200 rpm under a supply head of 120 ft. The guide vane angle is 10° and 70° of the pressure drop takes place in the guides which have a velocity coefficient of 0.95. At the wheel discharge the press is atmos., and the discharge angle is 36°. The loss in head in the wheel is equal to ½% of the total supply head and the width of the runner at inlet is 9°. m of turbine = 90%. Calculate the runner vane inlet angle: hyd and bhp developed.

UNIT # 5 - Centrifugal Pumps

General Objective: The student will be able to successfully deal with numerous aspects of centrifugal pump design.

Specific Objectives:

1. To be able to state the runner equation for a centrifugal pump.

2. To be able to produce the inlet and outlet velocity triangles for a centrifugal pump.

3. a) To be able to define the term static lift.
   b) To be able to define the term suction lift.
   c) To be able to define the term delivery lift.

4. To be able to define the term Manometric Head.

5. To be able to define the term Manometric Efficiency.

6. To be able to interpret Centrifugal Pump Characteristic curves.

7. To be able to define the term Specific Speed.

8. To be able, with the aid of the above specific objectives, to solve correctly problems of the following type:

   A centrifugal pump impeller has a peripheral speed of 85 ft/sec and the diameters are in the ratio 8:17. The water enters the impeller radially at an obsolute velocity of 15 ft/sec and the flow areas at inlet and outlet are 100 and 90 in^2 respectively. The vanes at outlet are set back at 30° to the tangent. Neglecting impeller losses and assuming that one third of the obsolute kinetic head at the impeller outlet is converted to pressure head in the volute, calculate the manometric head and the manometric efficiency.

<u>UNIT #6 - Hydraulic Couplings</u>

General Objective: The student will be able to deal with problems regarding hydraulic couplings and torque converters.

<u>Specific Objectives</u>:

1. To be able to define the term fluid coupling.
2. To be able to define the term torque converter.
3. To be able to distinguish between and explain the fluid coupling and torque converter curves.
4. To be able to define the term slip of a fluid coupling.
5. To be able to recall the formula for power in a rotating machine.
6. To be able to define the efficiency of a fluid coupling.
7. With the aid of the above specific objectives, to be able to solve problems of the type Binder 16-33 and 34.

MECHANICS OF FLUIDS

TOPIC NO.	PERIODS	TOPIC DESCRIPTION
1	4	Dimensional Analysis
2	4	Dynamical Similarity
3	12	Pelton Wheels
4	20	Impulse & Reaction Turbines
5	20	Centrifugal Pumps